Performance Analysis of Shell And Tube Heat Exchanger By Ansys/CFD For Effective Utilization of Energy

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Abstract- *Convection heat transfer in a shell-and-tube heat ex changer using sheet fins is numerically investigated. Heat and mass transfer in the heat ex-changer are modeled under steady state to estimate the heat transfer rate and the pressure drop for various geometries of the heat ex changer fins. Based on the numerical results, find suitable fins were identified. For convenience similar expressions to those of conventional shell -and –tube heat ex changers, that is , the function of dimensionless numbers such as the Reynolds number, are derived in these equations, the geometry of the heat exchange, fin efficiency , and contact thermal resistance are include as major factors on formulating the equation for the overall heat transfer rate. It is found that the heat transfer coefficient for the heat ex-changer with fin does not correspond to the combination to the coefficient of bare tubes surface and the fin. This is because the heat exchange area is substantially limited especially at the narrow space between the tube and the fin. A correction factory for the substantially heat transfer areas therefore introduced. These formulated equations are helpful for installing sheet fins in manufactured heat exchangers using the formulated equations. Effective conditions to enhance heat transfer rate by the fin are established, taking into account the increase in pressure drop.*

I. INTRODUCTION

Thermal design of shell-and-tube heat exchangers (STHEs) is done by sophisticated computer software. However, a good understanding of the underlying principles of exchanger design is needed to use this software effectively. This article explains the basics of exchanger thermal design, covering such topics as: STHE components; classification of STHEs according to construction and according to service; data needed for thermal design; tube side design; shell side design, including tube layout, baffling, and shell side pressure drop; and mean temperature difference. The basic equations for tube side and shell side heat transfer and pressure drop are well known; here we focus on the application of these correlations for the optimum design of heat exchangers. A follow-up article on advanced topics in shell-and-tube heat exchanger design, such as allocation of shell side and tube side fluids, use of multiple shells, overdesign, and fouling, is scheduled to appear in the next issue

Components of STHEs It is essential for the designer to have a good working knowledge of the mechanical features of STHEs and how they in fluence thermal design.

The principal components of an STHE are:

1. Shell
2. Shell cover
3. Tubes
4. Channel
5. Channelcover
6. Tubesheet
7. Bafflesand
8. Nozzles.

Other components include tie-rods and spacers, pass partition plates, impingement plate, longitudinal baffle, sealing strips, supports, and foundation. The Standards of the Tubular Exchanger Manufacturers Association (TEMA) (1) describe these various components in detail. An STHE is divided into three parts: the front head, the shell, and the rear head. Figure 1 illustrates the TEMA nomenclature for the various construction possibilities. Exchangers are described by the letter codes for the three sections — for example, a BFL exchanger has a bonnet cover, a two-pass shell with a longitudinal baffle, and a fixed-tube sheet rear head.

II. LITERATURE SURVEY

S.Rajasekaran, et al (2010) , The objective of this paper is to Develop and Test a model of optimizing the early design phase of shell and Tube Heat Exchangers via the application of modified Genetic Algorithm (MGA).The Modified Genetic Algorithm is based on the integration of classical genetic algorithm structure and a systematic neighborhood structure .The MGA model can help the designers to make decisions at the early phases of the design process. With a MGA model, it is possible to obtain an approximately better prediction, even when required information is not available in the design process. This model proved that MGA is capable of providing better solutions with higher quality even with inadequate data.

Chen Fang, et al (2010), Vapor-venting micro channel heat exchangers are promising because they address the problems of high pressure drop, flow instability, and local dry out that are common in conventional two-phase micro channel heat sinks. We present a 3D numerical simulation of the vapor-venting process in a rectangular micro channel bounded on one side by a hydrophobic porous membrane for phase-separation. The simulation is based on the volume of fluid (VOF) method together with models for interphase mass transfer and capillary force. Simulation shows the vapor-venting mechanism can effectively mitigate the vapor accumulation issue, reduce the pressure drop, and suppress the local dry-out in the micro channel. Pressures urge is observed in the vapor-venting channel. The simulation provides some insight into the design and optimization of vapor-venting heat exchangers.

Praful Date1, et al (2013), proposed the novel approached toward the heat transfer enhancement of plate and fin heat exchanger using improved fin design facilitating the vortex generation. The vortex generator can be embedded in the plane fin and that too in a low cost with effect the original design and setup of the commonly used heat exchangers. The various design modifications which are implemented and studied numerically and experimentally is been discussed in the paper.

Akpa, J. G.,, et al (2011),Mathematical models that can be used to predict the transient behavior of heat exchangers in a Heat exchanger Network (HEN) have been developed. This analysis is aimed at predicting thermal transients in Heat Exchanger Networks due to temperature fluctuations of inlet streams. This model is used to predict thermal transient of the heat exchanger networks in the crude distillation unit of the New Port-Harcourt refinery. The response of heat exchangers in the entire network to transient input (sinusoidal change in inlet temperature of the cold stream) was investigated. A finite difference numerical scheme is used to develop a solution algorithm for solving the set of partial differential model equations. The results reveals the effect of inlet temperature change on the process streams and possible points where temperature control is required in the heat exchanger networks of the NewPort Harcourt refinery.

F. Vera-García, et al(2010) , In this paper, a simplified model for the study of shell-and-tubes heat exchangers (HXs) is proposed. The model aims to agree with the HXs when they are working as condensers or evaporators. Despiteits simplicity, the model proves to be useful to the pre-design and correct selection of shell-and-tubes HXs working at full and complex refrigeration systems. The heat transfer coefficient and pressure drop correlations are specially selected and treated to implement them into the shell-and-tubes HXs presented. The model is implemented and tested in the metallization of a general refrigeration cycle and the results are compared with data obtained from a specific test bench for the analysis of shell-and-tubes HXs.

III. METHODOLOGY

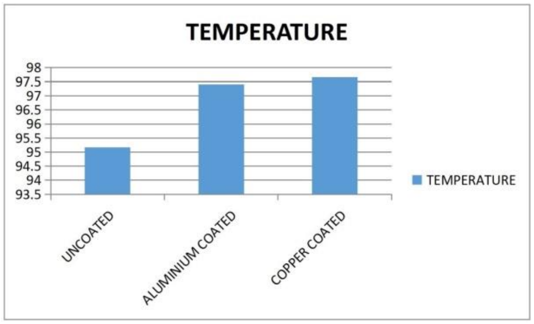
Modeling and analysis of 3-D models of the heat exchangers were carried out using ANSYS and CFD software. Analysis of different materials will carried out by ansys software and flow characterization of different shape of heat exchanger is carried out by CFD software.

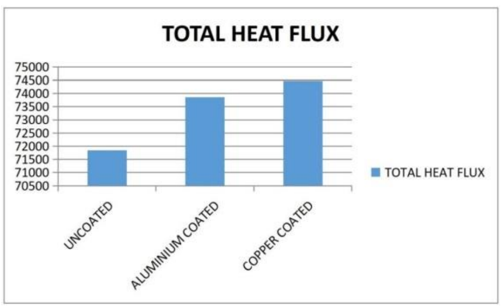
To investigate the stress distribution, thermal and heat flow analysis of single, double and triple baffle segment arrangements. Various materials of heat exchangers. A parametric study of heat exchangers by varying the three dimensional parameters of the heat exchangers will be carriedout. To investigate the stress distribution, thermal and heat flow analysis of single, double and triple baffle segment arrangements. Various materials of heat exchangers. A parametric study of heat exchangers by varying the three dimensional parameters of the heat exchangers will be carriedout.

A third type of heat exchanger is a plate and shell heat exchanger, which combines plate heat exchanger with shell and tube heat exchanger technologies. The heart of the heat exchanger contains a fully welded circular plate pack made by pressing and cutting round plates and welding them together. Nozzles carry flow in and out of the plate pack (the 'Plate side' flow path).The fully welded plate pack is assembled into an outer shell that creates a second flow path (the 'Shell side'). Plate and shell technology offers high heat transfer, high pressure, and high operating temperature, compact size, low fouling and close approach temperature. In particular, it does completely without gaskets, which provides security against leakage at high pressures and temperatures.

IV. RESULT AND DISCUSSION

From the analysis it may identified that the suitable material for heat exchanger tube and identified perfectl design for shell and tube heat exchanger.





Thus the heat flux graph is also higher in the copper coated steel. so what the copper coated is more efficient and the pressure drop is lower in the copper coated steel. Thus the tube can constructed with the copper coated and the shell and heat tub exchanger is placed with the tubes and the angles can also be changed for more effective.

V. CONCLUSION

Conventional methods used for the design and development of Heat Exchangers are expensive. CFD provide alternative to cost effectiveness speedy solution to heat exchanger design and optimization. CFD results are the integral part of the design process and it has eliminated the need of prototype .due to the development of CFD models, the use of CFD is no longer a specialist activity. It is accessible to process engineers, plant operator and manager. CFD is still a developing art in prediction of erosion/ corrosion due to lack of suitable mathematical models to represent physical process. From the numerical analysis, it may expect that that the shell and tube heat exchanger is better than types like single and triple baffles type heat exchangers. Also is found that the well-defined shell and tube heat exchanger is having more heat flux and thermal distribution. This will further improve the performance of the heat exchangers.

REFERENCES

[1] B. Allen, L. Gosselin, Optimal geometry and flow arrangement for minimizing the cost of shell-and-tube condensers, International Journal of Energy Research 32 (2008)958–969.
[2] K. Beatty, D. Katz, Condensation of vapors on outside of finned tubes, Chemical Engineering Progress 44 (1948)55–77.
[3] M. Belghazi, A. Bontemps, C. Marvillet, Condensation heat transfer on enhanced surface tubes: experimental results and predictive theory, Journal of Heat Transfer 124 (2002)754–761.
[4] K. Bell, A. Mueller, Engineering Data Book II, Wolverine,2001.
[5] L. Boyko, G. Kruzhilin, Heat transfer and hydraulic resistance during condensation of steam in a horizontal tube and in a bundle of tubes, International Journal of Heat and Mass Transfer 10 (1967)361–373.
[6] L. Bromley, Heat transfer in stable film boiling, Chemical Engineering Progress 46 (1950)221–227.
[7] M. Browne, P. Bansal, An elemental ntu-e model for vapour-compression liquid chillers, International Journal of Refrigeration 24 (2001)612–627.
[8] R. Cabello, J. Navarro-Esbrí, R. Llopis, E. Torrella, Analysis of the variation mechanism in the main energetic parameters in a single-stage vapour compression plant, Applied Thermal Engineering 27 (2007)167–176.
[9] R. Cabello, E. Torrella, J. Navarro-Esbrí, Experimental evaluation of a vapourcompression plant performance using r134a, r407c and r22 as working fluids, Applied Thermal Engineering (2004)1905–1917.
[10] M. Cooper, Heat flow rates in saturated nucleate pool boiling, Advances in Heat Transfer 16 (1984)157–239.
[11] J. Corberán, P.F. de Córdoba, J. Gonzálvez, F. Alias, Semiexplicit methodfor wall temperature linked equations (SEWTLE): a general finite-volume technique for the calculation of complex heat exchangers, Numerical Heat Transfer (2000) 37–59.
[12] J. Corberán, J. Gonzálvez, P. Montes, R. Blasco, 'ART' A computer code to assist the design of refrigeration and A/C equipment, in: Ninth International Refrigeration and Air-Conditioning Conference, Purdue,2002.
[13] J. Corberán Salvador, J. Gonz-lvezMaciá, M.J., T.C., Modelado general deintercambiadores de calor de placas

con conducción longitudinal, in: Congreso Nacional de IngenieríaMecánica,2002.
[14] F. Dittus, L. Boelter, Heat transfer in automobile radiators of the tubular type, International Communications in Heat and Mass Transfer (1985)3–22.
[15] J. Garcia-Cascales, F. Vera Garcia, J. Corberan-Salvador, J. Gonzalvez-Macia, D.Fuentes-Diaz, Assessment of boiling and condensation heat transfer correlations in the modelling of plate heat exchangers, International Journal of Refrigeration 30- 6 (2007)1029–1041.
[16] J. Garcia-Cascales, F. Vera-Garcia, J. Corberan-Salvador, J. Gonzalvez-Macia, D.Fuentes-Diaz, Assessment of boiling heat transfer correlations in the modeling of tube and fin heat exchangers, International Journal of Refrigeration 30 (6) (2007) 1004–1017.
[17] G. Hewitt, G. Shires, T. Bott, Process Heat Transfer, CRC Press Inc.,1994.
[18] U. Kapale, S. Chand, Modelling for shell-side pressure drop for liquid flow in shell-and-tube heat exchanger, International Journal of Heat and Mass Transfer 49 (2006)601–610.
[19] A. Karno, S. Ajib, Effect of tube pith on heat transfer in shell-and-tube heat exchangers–newsimulation software, Heat and Mass Transfer 42(2006)263–270.
[20] W. Kays, A. London, Compact Heat Exchangers, third ed., McGraw-Hill Company,1984.